Radiological Evaluation of the Tuffier's Line in Pediatric Patients

Pediatrik Hastalarda Tuffier Çizgisinin Radyolojik Değerlendirilmesi

Tuffier's Line in Pediatric Patients

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Özet

Amaç: Tuffier çizgisi her iki iliak kristanın en yüksek noktalarının birleştiği hat olarak tanımlanmakta olup genellikle L4 vertebra gövdesinden yada L4-5 vertebral aralıktan geçmektedir. Bu çalışmada Tuffier çizgisinin pediatrik popülasyonda yaş ve cinsiyetle değişimi radyolojik olarak değerlendirilmiştir. Gereç ve Yöntem: Bu çalışmada 16 yaş ve daha küçük 519 hastanın ayakta antero-posterior lomber radyografileri retrospektif olarak değerlendirilmiştir. Değerlendirme şu sıradaki gibi yapıldı: L4 vertebra gövdesi , L4 inferior endplate, L4–L5 disk aralığı, L5 superior endplate, L5 vertebra gövdesi, L5 inferior endplate, L5-S1 disk aralığı.Hastaların cinsiyet, yaş ve Tuffier çizgilerinin vertebral seviyeleri kaydedildi. Veriler ki-kare testi ile analiz edilmiştir. Bulgular: 315 erkek ve 204 kadın hasta vardı.Tuffier hattı düzeyinde kadın ve erkekler arasında anlamlı bir fark yoktu (p=0.102). Hem erkek hem de kadın gruplarında Tuffier hattı L5 vertebra gövdesinden geçme eğilimindeydi, sırasıyla% 44.8 ve% 46.1. Tuffier hattı düzeyinde yaş grupları arasında anlamlı bir fark yoktu (p<0.001). Tuffier çizgisi yaşla birlikte anlamlı olarak yükselme eğilimindeydi. Tartışma: Erkeklerle kıyaslandığında Tuffier çizgisinin kızlarda benzer olduğu ve genç yaş gruplarında önemli ölçüde daha düşük bir konumda olduğu bu çalışmada gösterilmiştir. Tuffier çizgisi pediatrik hastalarda artan yaş ile birlikte anlamlı olarak yükselme göstermektedir.

Anahtar Kelimeler

Tuffier Çizgisi; Kristalar Arası Hat; Pediatrik; Yaş; Cinsiyet

Abstract

Aim: Tuffier's Line (Intercristal line) is defined as the line connecting the highest points of both iliac crests which generally passes through either the body of the L4 vertebra or the intervertebral space between L4-5 vertebrae. In this study, we assessed the radiological evaluation of the level of Tuffier's line with changes in age and gender in pediatric population. Material and Method: In this study, standing anteroposterior lumbar radiographs of 519 patients aged 16 and younger were analyzed retrospectively. Notation was made as to the intersection of this line with one of the following structures: L4 vertebral body, L4 inferior endplate, L4–L5 disc space, L5 superior endplate, L5 vertebral body, L5 inferior endplate, L5-S1 disc space. Patients' gender, age and vertebral level of the Tuffier's line are recorded. Data is analyzed with chi-square test. Results: There were 315 male and 204 female patients.There were no significant difference between females and males on the level of Tuffier's line (p=0.102). In both male and female groups Tuffier's line tended to pass through the L5 vertebral body, respectively 44.8 % and 46.1 %. There was a significant difference between age groups on the level of Tuffier's line (p<0.001). Tuffier's line were significantly increased with ascending ages. Discussion: This study clearly demonstrated that the Tuffier's line were in a similar position in females compared to males and also Tuffier's line were in a significantly lower position in younger age groups.Tuffier's line were significantly increase with ascending ages in pediatric patients.

Keywords

Tuffier's Line; Intercristal Line; Pediatric; Age; Gender

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Introduction

Tuffier's line (Intercristal line) is a clinical landmark defined as a horizontal line connecting the superior aspect of the posterior iliac crests. Generally, it is known that Tuffier's line intersects the spine at the L4 spinous processor at the L4-L5 intervertebral space [1]. Generally, many anesthesiologists use Tuffier's line as an anatomical landmark in spinal and epidural anesthesia. Even experienced anesthesiologists in previous studies have shown that the failure to identify the lumbar intervertebral space with physical examination. [2]. Also, previous studies showed that a variable Tuffier's line position according to age, gender, and race [3-5]. Due to these differences correct anatomic identification of Tuffier's line is important to prevent spinal cord injury in procedures [6]. The currently used clinical method is to determine the vertebral level with Tuffier's line based on palpation. However, the vertebral level determined by such a method may be inaccurate. When used as the sole method to identify lumbar spinal levels for diagnosis and treatment, Tuffier's line has been consistently shown to be an unreliable landmark. There have been numerous anatomical studies in adults looking at the relationship of Tuffier's line to vertebral levels [3]. However, studies on this subject are limited in the pediatric population. The following study specifically evaluated the relationship between sex and age groups with the level of Tuffier's line to determine in pediatric population.

Material and Method

Institutional ethics committee approval were obtained for the study. Between 01.01.2009 - 31.11.2014, standing anteroposterior lumbar radiographs of different 600 patients under 16 years were evaluated retrospectively. Exclusion criteria for subjects were known congenital vertebral anomalies of the lumbar spine, history of spinal surgery in the lumbar or low thoracic region, or ankylosing spondylitis in medical records. And also patients with poor image quality were excluded from the study. Sex and age of all patients was obtained from medical records. Age groups are designated as follows: 0-3 yr, 4-7 yr, 8-11 yr and 12-16 yr.

All radiographs were evaluated by two experienced anesthesiologists in this regard. Electronic data base pointer of the radiography program was used to determine the Tuffier's line and thus is likely incorrect drawings and evaluator errors was minimized. The height of Tuffier's line was determined by the level of the horizontal linea cross the superior aspect of both iliac crests. Notation was made as to the intersection of this line with one of the following structures:

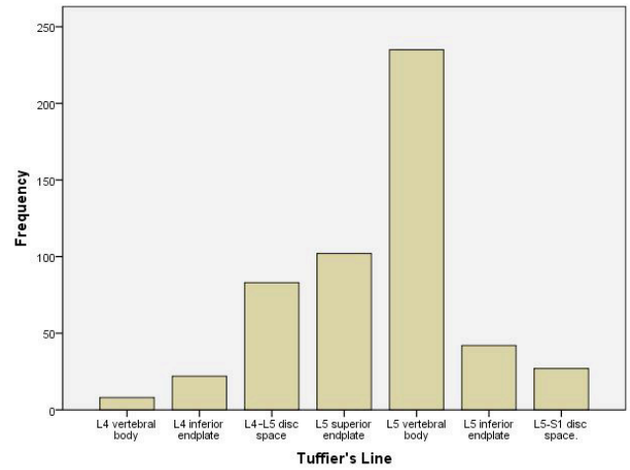
1. L4 vertebral body
2. L4 inferior endplate
3. L4–L5 disc space
4. L5 superior endplate
5. L5 vertebral body
6. L5 inferior endplate
7. L5-S1 disc space

Statistical analysis was carried out by a statistical soft ware package (SPSS 20.0® SPSS, Chicago. USA). Data are expressed as percentage or number of patiens. Fisher exact test was used to test for differences in the level of Tuffier's line between gender and age groups. All statistical analysis were considered significantif $p< 0.05$ in all the comparisons.

Results

Six hundred standing anteroposterior lumbar radiographs were reviewed to determine the level of Tuffier's line in the standing position. According to the exclusion criteria 81 of them were excluded from the study. As a result, the images of 519 different patients were included in the study. Within the entire sample, the level of Tuffier's line varied between the body of L4 and the disc space of L5-S1, and percentage distribution was as follows: L4 vertebral body (1.5 %), L4 inferior endplate (4.2 %), L4–L5 disc space (16 %), L5 superior endplate (19.7 %), L5 vertebral body (45.3 %), L5 inferior endplate (8.1 %), L5-S1 disc space (5.2 %) (Fig. 1).

Fig 1. Distribution of the Tuffier's Line of 519 pediatric patients.



Distribution by gender of the Tuffier's Line seen in Table 1. There were 315 male and 204 female patients.There were no significant difference between females and males on the level of Tuffier's line (p=0.102) (Table 1). In both male and female

Table 1. Distribution by gender of the Tuffier's Line

			Gender		Total	p
			Male	Female		0.102
Tuffier	1	Count	5	3	8	
		% within gender	1,6%	1,5%	1,5%	
	2	Count	10	12	22	
		% within gender	3,2%	5,9%	4,2%	
	3	Count	59	24	83	
		% within gender	18,7%	11,8%	16,0%	
	4	Count	65	37	102	
		% within gender	20,6%	18,1%	19,7%	
	5	Count	141	94	235	
		% within gender	44,8%	46,1%	45,3%	
	6	Count	19	23	42	
		% within gender	6,0%	11,3%	8,1%	
	7	Count	16	11	27	
		% within gender	5,1%	5,4%	5,2%	
Total		Count	315	204	519	
		% within gender	100,0%	100,0%	100,0%	

Tuffier; 1: L4 vertebral body, 2: L4 inferior endplate, 3: L4–L5 disc space, 4: L5 superior endplate, 5: L5 vertebral body, 6: L5 inferior endplate, 7: L5-S1 disc space.

groups Tuffier's line tended to pass through the L5 vertebral body, respectively 44.8 % and 46.1 % (Table 1).

Distribution by age groups of the Tuffier's Line seen in Table 2. The number of patients in the groups were as follows: 0-3 yr (36),4-7 yr (229), 8-11 yr (198) and 12-16 yr (56). There was a significant difference between age groups on the level of Tuffier's line ($p<0.001$) (Table 2). In 0-3 yr age group Tuffier's line tended to pass through the L5 vertebral body 61.1 %. In other age groups, this rate has been gradually decreasing, respectively 48.0 %, 42.4 % and 33.9 % (Table 2). Tuffier's line were significantly increased with ascending ages (Table 2).

Table 2. Distribution by age groups of the Tuffier's Line

			Age groups				Total	p
			0-3	4-7	8-11	12-16		<0.001
Tuffier's	1	Count	0	1	5	2	8	
		% within age groups	,0%	,4%	2,5%	3,6%	1,5%	
	2	Count	1	4	10	7	22	
		% within age groups	2,8%	1,7%	5,1%	12,5%	4,2%	
	3	Count	1	30	36	16	83	
		% within age groups	2,8%	13,1%	18,2%	28,6%	16,0%	
	4	Count	1	51	40	10	102	
		% within age groups	2,8%	22,3%	20,2%	17,9%	19,7%	
	5	Count	22	110	84	19	235	
		% within age groups	61,1%	48,0%	42,4%	33,9%	45,3%	
	6	Count	5	19	16	2	42	
		% within age groups	13,9%	8,3%	8,1%	3,6%	8,1%	
	7	Count	6	14	7	0	27	
		% within age groups	16,7%	6,1%	3,5%	,0%	5,2%	
Total		Count	36	229	198	56	519	
		% within age groups	100,0%	100,0%	100,0%	100,0%	100,0%	

Tuffier; 1: L4 vertebral body, 2: L4 inferior endplate, 3: L4–L5 disc space, 4: L5 superior endplate, 5: L5 vertebral body, 6: L5 inferior endplate, 7: L5-S1 disc space.

Discussion

Tuffier's line is a clinical landmark defined as a horizontal line connecting the superior aspect of the posterior iliac crests and commonly used as a reference to localize the L4 vertebral body before performing a lumbar puncture [7]. However Tuffier's line is unreliable in determining the correct lumbar vertebral level. As a proof Reynolds described seven cases where neurological damage followed spinal or combined spinal-epidural anesthesia in adult women [6]. Perhaps this has been the inspiration for many studies however despite being more studies are conducted in the adult population, studies in the pediatric age group are not sufficiently available.

MR imaging studies demonstrated that the Tuffier's line were in a significantly lower position in females compared to males in adults [4,8]. A similar result demonstrated by Windisch et al. in a cadaveric study [9]. Shiraishi et al who found that the intercristal line passes through the body and lower one-third of L4 in men and the body and upper one-third of L5 in women [10]. MacGibbon et al also found that Tuffier's line was significantly lower in women than in men [11]. In a study that evaluated the adult population of the lumbar radiographs Snider et al. showed that Tuffier's line demonstrates predictable sex-related anatomic differences with men having an intercristal line that most often intersects the body of L4 or its inferior endplate and with women having the intercristal line most often intersect the body of L5 or its superior superior endplate [7]. And also showed that weight and BMI are not associated with the level of Tuffier's line in this study.

In contrast to the results of previous adult studies in our study Tuffier's line did not show any differences between the gender in the pediatric population. Different from adults radiographic evaluation we found that the intercristal line passes through the L5 vertebral body in both gender.

A pediatric anaesthesia textbook suggests that the height of the line varies from L5-S1 in neonates, to L5 in children, and higher again in larger children and adults [12]. Pediatric anesthesia textbooks contend that Tuffier's line crosses the midline in the area of about L5 in infants and at about L5-S1 in neonates [13]. Tame et al. have evaluated the lumbar MRI of 49 pediatric patients under 10 years in their study and showed that there is some variation in the Tuffier's line in children [14]. They found a range in levels from L4 to L5 for the Tuffier's line and this study demonstrated radiologically that Tuffier's line can be relied upon to identify the L4-5 intervertebral space in children.

Differently from results of the Tame et al. we found a range in levels from L4 vertebral body to L5-S1disc space for the Tuffier's line. We think the reason of this situation was originated different age groups of our study. But also we agree that Tuffier's line can be relied upon to identify the L4-5 intervertebral space in children.

As our study, most of these studies were all performed without lumbar flexion. However, patients are normally flexed to increase the area of the lumbar interlaminar spaces when diagnostic spinal punctures or lumbar spinal or epidural blocks are performed.This situation can be considered as a limitation. However in an adult study when compared with the neutral position, the position of the Tuffier's line usually does not change with full flexion of the lumbar spine [15].

In conclusion our findings clearly demonstrated that the Tuffier's line were in a similar position in females compared to males. However, Tuffier's line were in a significantly lower position in younger age groups.Tuffier's line were significantly increase with ascending ages in pediatric patients.

Competing interests

The authors declare that they have no competing interests.

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